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Laminating Apparatus

Background of the Invention

Sandwich elements have been commonly used in buildings and in ships for many years. They were first used in the form of thin concrete layers separated by an isolating layer, the core. Very often there was a mechanical connection between the concrete layers because the core usually could not transfer the forces necessary for holding the element together. Later sandwich elements were introduced in which the surface layers were made of thin layers, e.g. sheet-metal or laminate. With thin and flexible surface layers, a need arose for rigid cores which were able to transfer forces. This need could be met with cellular plastics, but the need, especially for fire protection and sound isolation, led to mineral wool becoming an important core material.

To make the mineral wool core rigid enough it is sometimes sufficient to increase its density. However it is more customary to change instead the orientation of the fibres in the core so that the main direction of the fibres is orthogonal to the surface plane. Using such a fibre orientation, allows the board to withstand deformation better when it is loaded orthogonally to its plane compared to a mineral wool core that is not reoriented. Reorientation can be carried out using a so called lamina technique, i.e. the normal hardened mineral wool boards are divided into narrow strips, which are rotated 90° around their own axis and assembled in a new sheet-type construction. Other techniques for carrying out the reorientation

totally smooth elements. The strength also deteriorates, which usually is not permissible. To eliminate these problems, the amount of glue, the thickness of the surface layers, the density of the mineral wool layer, the binding agent concentration etc. has been increased or the surface has been additionally machined. Additional glue and binding agent contents result however in inferior fire properties. Another fact is that the product will be much more expensive, and, besides, the result is often not good enough or predictable. Not the least serious problem is, that more expensive measures have to be taken also on elements which have no obvious weaknesses.

In the light of this, extensive and thorough studies and experiments have been made, which have given rise to the invention according to WO 98/42503. According to this publication, the pressing, when needed under heating, is not carried out against a stopping block to a predetermined thickness, but by using a pressure within a predetermined range, P_{max} - P_{min}, the size of which is determined by the included components, the mineral wool laminas, the surface layers and the glue. In this case both the terminal points of the interval are determined by two different phenomena: the lower limit for the pressing pressure being the lowest pressure needed so that no adhesion breakage will occur; the upper limit being determined by how much the core material withstands while retaining its structural properties.

An important problem remains in this known method,

Object of the Invention

It is an object of the present invention to overcome or ameliorate some of the disadvantages of the prior art, or at least to provide a useful alternative.

Summary of the Invention

There is firstly disclosed herein a method of connecting surface layers and a core to a sandwich element through putting together the surface layers and the core into a press object after adding a glue layer between these, which after this is subjected to pressing in a press between two press platens, while the glue is cured, whereby at least one of the press platens is flexible and is acted on by several power units, which are arranged over the press platen and which are arranged at a relative distance from each other, which power units act against a fixed supporting structure, and a pressing pressure is applied on the press object, wherein the press object is subjected by means of the power units to a pressure which causes a certain compression to it and defines its thickness without any elements limiting the compression of it, whereby the power units during the pressing are controlled individually or in groups, so that local deviations from the pressing pressure are kept within predetermined intervals.

There is further disclosed herein a press for connecting surface layers and a core in an element in which the surface layers and the core are assembled to form a press object after adding a glue layer between the surface layer and core, which then is subjected to pressing between two press platens, wherein at least one of the press platens is flexible and is acted on by several power units, which are arranged between the press platen and a fixed supporting structure so that they can produce forces which can be transferred from the fixed supporting structure to this press platen and the influence of which can be controlled individually or in groups, and wherein the flexibility of the flexible press platen has been chosen in relation to the position of the power units over the press platen so that the power units can be adjusted to exert a local pressure against the press object which lies within a predetermined range for defining the thickness of the press object without any elements limiting the compression of it.

In summary, when thin surface layers, e.g. made of sheet-metal, must be attached to a core made of reoriented mineral wool in a sandwich element, according to at least a preferred embodiment of the invention, a laminating apparatus is used in which at least one

In a normal case the influence of the power units shall be controlled in such a manner that both flexible press platens becomes both parallel to each other and flat. As aforesaid, the aim can be elements, which have curved cross-sections and in these cases the press platens must anyway be parallel.

By continuous pressing, the optimal curing of the glue may require the press platens to be flat but convergent or divergent.

For an optimal glue effect it is necessary for the press platens to exert a pressure against the press object within predetermined limits, in which the lower limit is determined by the lowest pressure, Pmin, which is needed so that when tearing apart the connection, adhesive failure will not occur, and the upper pressure, Pmax, is determined by the condition that the proportionality limit of the core material not shall be reached.

The limits are, at their broadest, Pmax and Pmin respectively, but they may also, when the practical possibilities in a specific case allow, be set so that the range becomes smaller, e.g. so that the lower press limit becomes Pmin + 0,25 * (Pmax - Pmin) and the upper press limit becomes Pmax - 0,25 * (Pmax - Pmin). In most cases it is both possible and desirable to accelerate the curing of the glue during the pressing action by heating from one or both of the press platens depending if there are surface layers on one or on two sides. Other types of accelerating effect

ture is distributed.

The heating of the surface platens may also be made in a separate step before they are fed into the press. This will also achieve other benefits because internal tensions and respectively changed dimensions of the surface layers by the heating can be dissolved and smoothened.

From many points of view it is advantageous that the press object is transported continuously through the press, partly because a higher production speed can be achieved and partly because elements can also be produced which are longer than the press or vice versa, allowing the press to be kept short.

Continuous production is possible in two ways, either by preparing separate press objects of certain length before the pressing or by preparing a continuous press object. In both cases, these are then taken continuously into, through and out of the press. To achieve continuous production in a press with press platens it is required that the press object be placed between two belts. For a press object that is taken through the press to be subjected to a pressure, the distance between the press platens must be less than the combined thickness of the press object and the belts in an unloaded condition.

the depth of the bends should be at most one thousand of its diameter.

The supporting structure against which the power units must act may be a platen or a framework made of beams or corresponding.

If the power units are elongated, e.g. they are pressure hoses, it is preferable that every or possibly every pair of them is controlled separately. If the power units are not elongated, but are arranged in rows, it is preferable that every such row is controlled separately.

The controlling must be adapted to the type of power unit used. If they are hydraulic, the adjustment is naturally performed by controlling the pressure of the pressure medium that feeds them. If the power units are of a different type, the size, and sometimes also the direction of the power with which they act on the flexible press platen, must be measurable, e.g. with some kind of detectors.

In a press it is normally preferable that the other press platen is smooth, preferably also stationary. The flexible press platen including its power units may then with preferably a control apparatus be made smooth and/or parallel to the other press platen.

Such a control apparatus may be more or less self-acting. To make the flexible press platen smooth, its deviation from smoothness is only measured in the sim-

be tubes. If cushions or hydraulic cylinders are selected instead, it is a beneficial to place these in rows. It is convenient that the elongated pressure units or rows of individual pressure units are arranged transversely to the flexible press platen, because the typical need is to eliminate its bending longitudinally. In many cases some other design is more advantageous, e.g. a herringbone pattern. If a controlled bending of the press platen is preferable, and preferably so that it gets a curved cross-section, the elongated power units or rows of power units must instead be arranged in the longitudinal direction of the press platen.

Usually it is preferable to accelerate the curing of the glue in some way when the press object is already situated between the press platens in the press by heating. Then it is required that one of the press platens or both are heated, e.g. with a circulating heating medium. Which medium is chosen depends mainly on the temperature the press platen or press platens shall obtain. This in turn depends on the properties of the glue and on the need to accelerate the process.

To be able to rapidly change to another thickness of the press object, it is preferable that the supporting structure, or in the case of two flexible press platens, at least one of the supporting structures is arranged to take different positions, e.g. defined by stopping blocks. The supporting structure can be a framework which with hydraulic cylinders can be lifted from and lowered against the stopping block. A series

pressing in a press with a working length of 5 m. The upper press platen of the press was flexible while the lower was rigid. The power units between the flexible press platen and its supporting structure was 16 tubes which extended across the press platen with a spacing of 330 mm. They were two and two connected to a hydraulic system with an individual pressure control to every tube pair. Both press platens had an internal system of bores in which water of temperature 92 °C flowed, which gave the press platens a temperature close to the press surfaces of 85,5 °C.

The press object was transported through the press with two conveyor belts. By pressing against a calibrating element the pressure in the different tube pairs was adjusted so that the flexible press platen was flat and parallel to the other press platen at a pressing pressure of 30 - 40 kPa.

The press object was a core of laminate oriented mineral wool of rockwool type with a density of 90 kg/m^3, the values of the density is normally for this case 70 - 120 kg/m^3, commonly 90 - 100 kg/m^3. The binding agent concentration was in the example 2,5 %. It is normally 2 - 4 %. The press object included a plastic coated steel plate layer on both sides. The thickness of the plate was 0,5 mm on one side and 0,6 mm on the other side.

In the example the length of the press object (a future sandwich element) was 7 m and the width was 1,2 m. Lengths of 6 - 10 m are typical, but the element

press object in principle can be pressed with a predetermined pressure all over its area. Possible local deviations from this pressure will then be kept within the limits P_{max} - P_{min} by controlling the power units individually or in groups.

Figures 2a, 2b, 3 and 4 are all diagrammatic representations of different embodiments of the apparatus according to the invention. Figures 2a and 2b show cross-sections while figures 3 and 4 show longitudinal views.

Figure 2a shows two columns (1) which are connected by an upper piece (2) and a lower press platen (3). An upper framework (4) is pressed by hydraulic cylinders (5) against adjustable stopping blocks (6). In connection with the upper framework (4) there is an upper, flexible press platen (7) which by power units (8) is pressed against the press object (9).

Figure 2b shows a corresponding apparatus, but with that difference that the flexible press platen (7) here is arranged in connection with a lower framework (10) and is pressed from this against the press object (9) by the power units (8).

In figure 3 reference number (15) represents a conveyor with driving rollers on which a press object (9), a future sandwich elements (23), lies. The press object consists of an upper surface layer (12) and a lower surface layer (13) between which there is a core of reoriented, e.g. lamina oriented, mineral wool

press frame (21) against the stopping blocks (6), after which the power units (8) further press the flexible press platen (7) against the press object with controlled pressures.

After the pressure has acted for the time needed for the glue to cure, the upper press frame is again raised, once the pressure from the power units has ended, so that the press object (9), which has now become a sandwich element (23), can be fed out. This takes place with the conveyor belt (18) out on the conveyor (24) at the same time that a new press object (9) is fed in from the other side.

Figure 4 shows an apparatus according to the invention which is intended for the continuous pressing of a continuous press object. A continuous core (14) of laminate oriented mineral wool is moved forward on a roller line. From two rollers, which are not shown in the figure, comes an upper (12) and a lower (13) surface layer made of plastic-coated steel plate down and respectively up against the continuous core. Before the surface layers are brought together with the core, the space between these is injected with a glue layer (27) from nozzles (28).

The, in this case continuous, press object (9) thus formed is taken with the conveyor belt (15) towards the press in between the lower belt (18), with its driving and turning rollers (19) and its supporting rollers (20), and the upper belt (29) with its driving and turning rollers (30) and supporting rollers (31).

pieces of suitable length. This cutting apparatus is not included in the invention and is also not shown in the figure.

The apparatus according to figure 4 can also be used for pressing prepared discontinuous press objects, the length of which consequently does not depend on the press length of the laminating apparatus. The prepared press objects may be longer than the press, but they may also be shorter and may then be fed in closely after each other.

distance between the press platens is less than the thickness of the press object and the belts together in an unloaded condition.

9. A press for connecting surface layers and a core in an element in which the surface layers and the core are assembled to form a press object after adding a glue layer between the surface layer and core, which then is subjected to pressing between two press platens, wherein at least one of the press platens is flexible and is acted on by several power units, which are arranged between the press platen and a fixed supporting structure so that they can produce forces which can be transferred from the fixed supporting structure to this press platen and the influence of which can be controlled individually or in groups, and wherein the flexibility of the flexible press platen has been chosen in relation to the position of the power units over the press platen so that the power units can be adjusted to exert a local pressure against the press object which lies within a predetermined range for defining the thickness of the press object without any elements limiting the compression of it.

10. The press according to claim 9, wherein the other press platen is flat and the press is arranged so that the power units can make the flexible press platen flat and parallel to this other press platen.

11. The press according to claim 9, wherein both press platens are flexible and both are acted on by several power units, which are arranged between the press platens and fixed supporting structures so that they can produce forces which can be transferred from the fixed supporting structures to the press platens and the influence of which can be controlled individually or in groups, and wherein the press is so arranged that the power units can make the press platens parallel and/or flat.

12. The press according to any one of claims 9 to 11, wherein the power units are elongated with a length that corresponds to the dimension of the flexible press platen in one direction or rows of individual pressure units with such a length.

13. The press according to claim 12, wherein the elongated power units or rows of individual pressure units are arranged across the flexible press platen.

14. The press according to any one of claims 9 to 13, wherein one or both press platens are heated, e.g. with a circulating heating medium.

15. The press according to any one of claims 9 to 14, wherein there is a belt which extends over the lower press platen so as to transport press objects through the press.

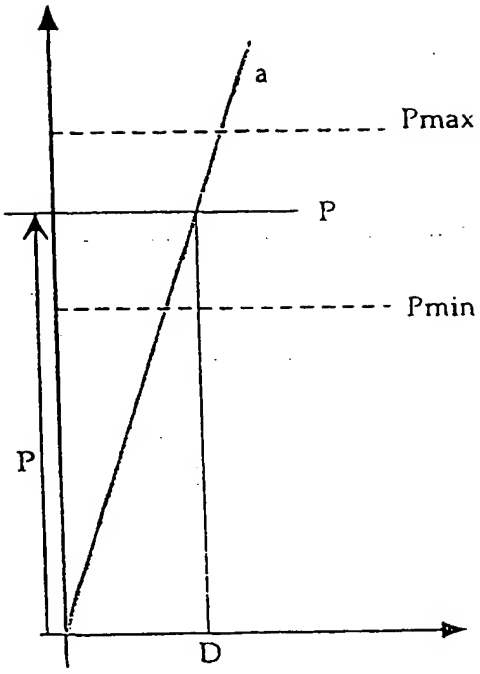

Fig. 1

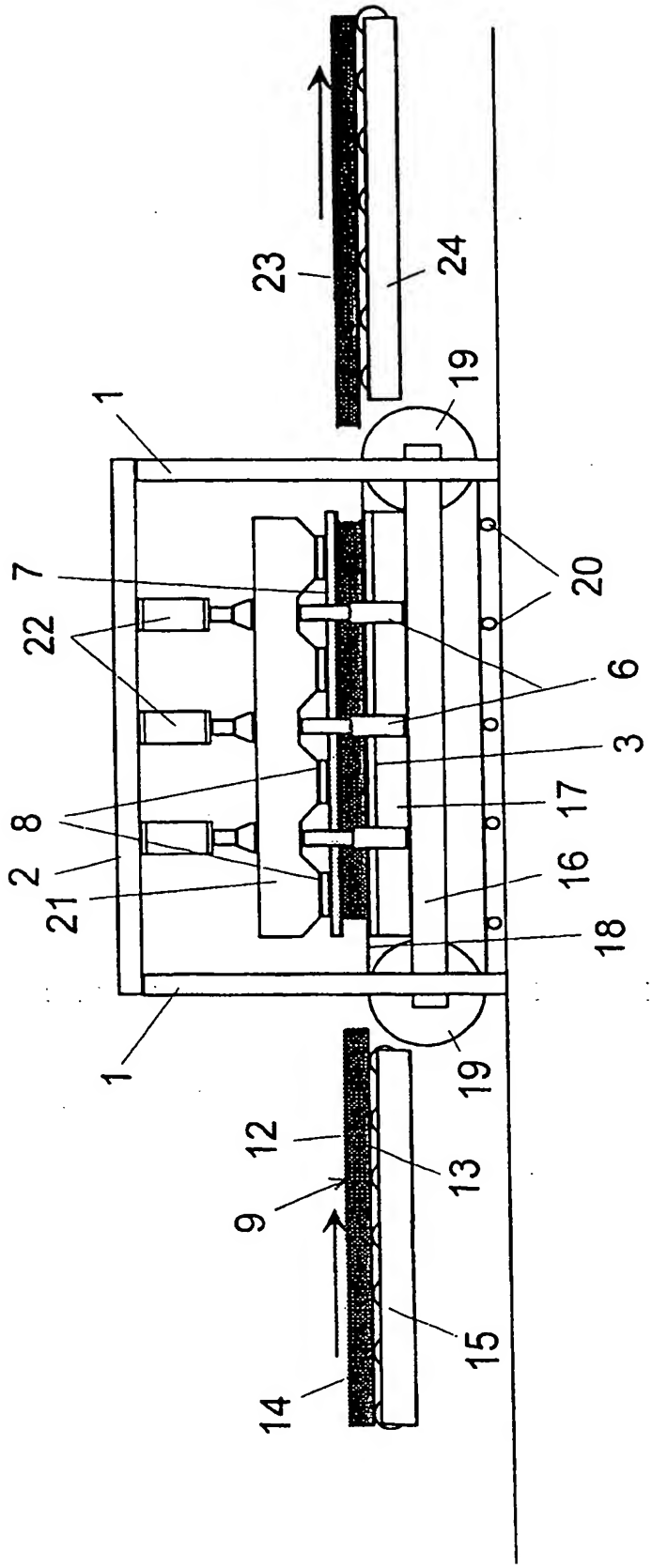

Fig. 3